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SCIENCE DIRECT
Renewable and Sustainable Energy Reviews
10 (2006) 152–163
RENEWABLE & SUSTAINABLE ENERGY REVIEWS
www.elsevier.com/locate/rser

Renewable energy policies in Turkey

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Received 12 February 2004; accepted 5 August 2004

Abstract

Achieving solution to environmental problems that we face today requires long-term potential actions for sustainable development. In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions. Although, Turkey has substantial reserves of renewable energy resources, actual utilization of these resources are quite low.

The aim of this study is to investigate the renewable energy policies and the political organizations that shape these policies. In these concept, The renewable energy potential of Turkey, the effective utilization of this potential, the energy politics, the political organizations, incentive, pricing and buying mechanisms, research and development studies, barriers for development of renewable energy are investigated in this paper. In conclusion, proposals and recommendations are given to overcome the problems.
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Keywords: Renewable energy sources; Energy policy; Solar energy; Wind energy; Geothermal energy; Biomass; Hydro power

Contents

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doi:10.1016/j.rser.2004.08.001

1. Introduction

Population of Turkey is about 65 million. The population growth rate is 1.7%, the highest among IEA countries. The country has a very dynamic economy. As a net effect of these factors, Turkey's energy demand is growing rapidly and is expected to continue grow in near future.

Although Turkey has a wide range of energy resources, these resources are limited. Since, Turkey is an energy importing country. More than about 60% of energy consumption in the country is met by imports and the share of imports continues to grow each year. Therefore, it is critical to supply its energy demand by using domestic non-renewable resources (such as lignite, hard coal, oil and natural gas) and renewable resources [1].

Renewable energy resources (solar, hydroelectric, biomass, wind, ocean and geothermal energy) are inexhaustible and offer many environmental benefits over conventional energy sources. Each type of renewable energy also has its own special advantages that make it uniquely suited to certain applications. Almost none of them release gaseous or liquid pollutants during operation. In their technological development, the renewable ranges from technologies that are well established and mature to those that need further research and development [2]. The other important factor of renewable resources is to create new employment opportunities.

Turkey's geographic location has several advantages for extensive use of most of the renewable energy sources. It is on the humid and warm climatic belt which includes most of Europe, the near east and western Asia. A typical Mediterranean climate is predominant at most of its coastal areas, whereas the climate at the interior part between the mountains that are a part of the Alpine Himalayan mountain belt is dry with typical steppe vegetation [3].

The subventions given to the renewable energy sources are compulsory till the sector come a competitive point with other energy sectors [4]. Every country has its subvention mechanism for renewable energy sources. These subventions can be grouped under three title: financial, tax and production subvention. For example, in Germany its compulsory to

buy the wind energy with a cost of 9 €c/kW h whereas the photo-voltaic energy is bought by 40 €c/kW h. Besides, the government gives subvention up to 25% of the investment value. 343.2 million Euro was spent between 1996 and 1997 for research and development (R&D) studies on the renewable energy sources [4]. There are only indirect subvention mechanisms exist in Turkey.

Numerous studies have been done by Turkish energy researchers on renewable energy technologies [5–21]. The basic difference of this study compare to other studies can be summarized as following: in previous studies mainly potential of renewable energies, utilization rates of these energies, energy conversion technologies and future developments are investigated. In this study addition to the some of these previous studies topics, energy policies, organizations that enforce these policies, pricing and buying mechanisms and R&D studies, barriers for development of renewable energy are investigated.

2. Energy resources of Turkey

Turkey does not possess huge fossil fuel reserves. Excluding lignite; coal, oil and natural gas reserves in the country are few and far from being able to meet the projected domestic demand. In a longer perspective, lignite deposits do not seem to be sufficient either. Turkey has substantial reserves of renewable energy sources.

2.1. Fossil energy sources

Coal is a major fuel source for Turkey. Domestically produced coal accounted for about 24% of the country's total energy consumption, used primarily for power generation, steel manufacturing and cement production [18]. Turkey is a large producer of lignite; proven reserves of lignite in the order of 8075, of which 7339 million tons is economically feasible, which comes predominantly from deposits in the southwest and the southeastern Afsin—Elbistan basin. The biggest lignite deposits, 40% of the total, are in Elbistan [18]. The government expects coal supply to rise from 20.1 Mtoe in 1999 to 118.4 Mtoe in 2020, more than five times current figures. It believes that domestic lignite production will almost triple.

The amount of fossil energy sources of Turkey is shown in Table 1.

Table 1
Amount of fossil energy sources in Turkey

Sources	Apparent	Probably	Possible	Total
Hard coal (million tons)	428	449	249	1126
Lignite (million tons)	7339	626	110	8075
Asphaltite (million tons)	45	29	8	82
Bituminous schist (million tons)	555	1086	269	1641
Oil (million tons)	36	–	–	36
Natural gas (billion cubic meter)	8.8	–	–	8

Source: Refs. [22–25].

2.2. Renewable energy resources

Turkey has substantial reserves of renewable energy resources. Renewable energy production represented about 14.4% of total primary energy supply (TPES), i.e. 10.10 million tons of oil equivalent (Mtoe) in 1999, and renewable are the second-largest domestic energy source after coal. Main renewable energy resources in Turkey are: hydro, biomass, wind, and biogas, geothermal, and solar.

According to recent studies, the economically usable hydropower potential of Turkey is estimated at 125,000 GW h per year (34,729 MW) as given in Table 2. 24,010 GW h of this potential was produced in operating hydro power plants (HPPs) in 2001 [25]. In addition to the dams and run off rivers and canals in operation, several others are in various stages, such as under construction, final design completed and final design in progress (Table 3). The Turkish government hopes that hydroelectric power plant capacity will expand to 35,000 MW by the year 2020.

It is estimated that the usable wind energy potential in Turkey, at around 8000 MW [21]. The western coast and southeastern Anatolia are very favorable locations for wind power generation, with annual average wind speeds around 2.5 m/s and annual wind power densities of 2.4 W/m^2. These regions are highly suitable for wind power generation, since wind speeds exceed 3 m/s in most of these areas. Old wind mills found in the Marmara and Aegean regions are good indicators of the wind energy potential for these regions [3]. The highest wind speed values are given in the literature as 5.1–5.2 m/s in Bandirma, progress in wind energy technology in recent years has drawn private-sector

Table 2
Hydropower potential of Turkey

Explanation	Power (MW)	Electricity generation (GW h/year)
Gross potential	49,427	433,000
Economically usable potential	34,729	125,000
Exploited potential (total in operation)	9865	36,000
Dams and HEPs	9349	33, 518
Run of river and canal HEPPs	516	2482

Source: Ref. [3].

Table 3
Potential of hydro power plants under construction at various stages

Explanation	Power (MW)	Electricity generation (GW h/year)
Dams (under construction)	3092	9809
Dams (final design completed)	4284	12,898
Dams (final design in progress)	926	3279
Run off river and canal (under construction)	111	406
Run off river and canal (final design completed)	284	1101
Run off river and canal (final design in progress)	123	476
Total	8820	27, 696

Source: Ref. [3].

attention to this energy resource. As a consequence, numerous companies have submitted their applications to The Ministry of Energy and Natural Resources (MENR) for the construction of new wind power plants and three plants have been commissioned. Turkey now has a clear target for wind generation, and numerous wind projects were submitted under the BOT programme in recent years. One of them is an auto-producer plant and the other two were built on the build-own-transfer (BOT) model. Wind power production is not very large, but total installed capacity has reached 18.9 MW and 72 new projects totaling about 2000 MW are under evaluation by the MENR [22]. The total production for the year 2001 is 152 GW h [25].

Solar energy has interesting potential in Turkey. Preliminary studies indicate that the country has an average 2640 sunshine hours annually, with an average solar intensity of 3.6 kW h/m^2 per day, with higher peaks at some locations. The total solar energy potential of Turkey is calculated as 35 mtoe per year [25]. In the year 2001 in Turkey, An estimated 287,000 tons of oil equivalent (toe) for solar heating are produced, especially in the southern and western regions and in the residential and commercial sectors [25].

The overall geothermal energy potential of Turkey is estimated at 35,000 MW. But, geothermal energy production for the year 2001 is only 1.759 Mtoe [23]. Its use is expected to increase to 6.3 Mtoe by 2020, especially for direct heating. The proposed Geothermal Law, currently being drafted by the MENR, should provide the necessary regulatory framework for this purpose.

Biomass energy includes agricultural residues, municipal wastes, fuelwood, animal wastes and other fuel derived from biological sources. The total recoverable bioenergy potential is estimated to be about 16.92 Mtoe. The estimate is based on the recoverable energy potential from main agricultural residues, livestock farming wastes, forestry and wood processing residues and municipal wastes as given in the literature. The biomass energy production for the year 2001 is 6.98 Mtoe [25].

3. Renewable energy policies

Energy development in Turkey has been dominated by public investment and management since independence in 1923, Although several waves of liberalization have been launched since 1983, leading to a gradual opening of the Turkish energy market and improving the situation. Turkey has made early and extensive use of financing models such as build-own-operate (BOO) and build-own-transfer (BOT). As yet, however, no decisive breakthrough has been achieved. In the last two years, several encouraging steps have been taken towards greater liberalization. The notion of privatization has been introduced into the Turkish constitution for the first time. Legislation was adopted in February 2001 to allow competition in the electricity market and adapt Turkey's legislation for European Union (EU) membership. A new Gas Market Law was adopted in May 2001 for the same purposes.

The main objectives of energy policy including renewable are [24]:

- To meet demand using domestic energy resources as the highest priority. In the medium and long term, this is to occur through a mix of public, private and foreign capital.

- To develop existing sources while acceleration the penetration of new and renewable sources.
- To diversify energy sources and to avoid dependence on energy imports from a single source or country.
- To encourage private sector investment and to accelerate capacity construction and privatization in the power industry. Preparations are to be made for the introduction of nuclear power.
- To improve the reliability of electricity supply through upgrades in the power transmission and distribution grid.
- To improve energy efficiency in end use and transformation, e.g. through reduction of losses in energy production, transmission and consumption.
- To protect the environment and public health.
- To make use of Turkey's geopolitical location to establish the country as a pivotal transit area for international oil and gas trade ('Eurasia energy corridor')

3.1. Renewable energy policy institutions

The Ministry of Energy and Natural Resources is the main body for the formation and implementation of energy policy in general and renewable energy in particular [24]. The Electric Power Resources Survey and Development Administration (EIEI) carry out investigations and surveys to identify the energy potential of water, wind and solar energy resources. If big hydropower generation is regarded in the renewable group, Directorate-General of State Hydraulic Works (DSI) is the main implementing organization.

The main state organizations having responsibility for planning the energy policy in Turkey are given in Table 4.

The main institutions operating under Ministry of Energy and Natural Resource have responsibilities for implementing energy policy are [24]:

- Directorate-General for Energy Affairs
- TEUAS, Turkish Electricity Generation Company
- TEIAS, Turkish Electricity Transmission Company
- TEDAS, Turkish Electricity Distribution Company
- TETTAS, Turkish Electricity Trading and Contractor Company

Table 4
The main state organizations having responsibility for planning the energy policy in Turkey

Organization name	Under the fold of
DPT, State Planning Organization	Prime Minister
TUBITAK, Scientific and Technical Research Council of Turkey	Prime Minister
Research, Planning and Co-ordination Board	Ministry of Energy and Natural Resources
Directorate-General for Energy Affairs	Ministry of Energy and Natural Resources
Directorate-General of Mineral Affairs	Ministry of Energy and Natural Resources
Directorate-General of Petroleum Affairs	Ministry of Energy and Natural Resources

- DSI, Directorate-General of State Hydrolic Works
- TPAO, Turkish Petroleum Company
- Directorate-General of Petroleum Affairs
- Directorate-General for Mining Affairs
- EIEI, Electric Power Resources Survey and Development Administration
- BOTAS, Turkish Pipeline Corporation
- TKI, Turkish Coal Enterprises
- Turkish Hard Coal Enterprises (TTK)

The above general directorates are operating under Minister and his Undersecretary. Therefore, main body responsible from energy policy is Ministry. All groups get or receive directives from ministry and implement the policy accordingly. As it was stated above, there is a separate Department of Energy Directorate General, which reports to Minister and his Undersecretary. Minister reports to Prime Minister.

There are also some non-Ministerial agencies responsible for various aspects of energy policy (Table 5).

3.2. Renewable policy instruments

In Turkey's case, where government expenditure has to be tightly controlled, it is important that the most cost-effective resources to be developed. Therefore, the government should attempt to develop competitive renewable energy supplies first, and provide base support for renewable energy, if necessary, on cost-effectiveness.

Turkey's renewable energy policies are being improved. Currently, there are a few Government-backed incentives to promote renewable energy investments. The MENR is

Table 5
Non-Ministerial agencies responsible for various aspects of energy policy

Organization name and/or regulation	Functions
Energy policy and/or regulation	Energy Market Regulatory Council
Nuclear power	Turkish Atomic Energy Authority (state organization)
Energy efficiency	ESÇAE/MAM/TUBITAK Marmara Research Center (state organization) some universities (presenting reports, organizing meetings and courses)
Energy standards	TSE, Turkish Standardisation Institute IEC, International Electrotechnical Commission
R&D	
	Energy Systems and Environmental Research Institute/Marmara Research Center
Renewable	
	Clean Energy Foundation
	Turkish Wind Energy Association
	International Solar Energy Society Turkish Section
	Geothermal Energy Association

Source: Ref. [22].

preparing a draft legislation which would allow certain renewable energy projects (mainly geothermal and wind, but also solar, wave, waste and landfill gas only) to be built and operated by the private sector, and provide incentives for such system. This legislation would also set the buy-back rates for renewable electricity. MENR has announced a target for wind energy, namely 2% of the total installed capacity by 2005. There is some municipal support in the area of geothermal heat as well. Private sector involvement in renewable energy promotion exists predominantly in the wind energy and small-scale solar projects [22].

All, the Ministry of Energy and Natural Resources (MENR), the State Planning Organization (DPT) and the Electric Power Resources Survey and Development Administration (EIEI) are involved in renewable energy promotion policies. Some promotions and related policies exist with respect to the development and implementation of geothermal heat and solar thermal energy production. Low-interest loans up to 45% of the capital cost are applicable to appropriate investments.

Until recently, Free Market Law of Electricity, the price of energy was decided as a result of negotiations between energy production company and the state which is buyer. This was a kind of incentive. Now, the price of the renewable energy will have to obey the market conditions.

3.3. Research and development on renewable energy

Financing of R&D projects are offered via national funds by DPT, TUBITAK-TIDEB and research funds of universities. The budgets are quite small. International co-operation is sought not only in terms of funds but also in terms of know how exchange [22].

The Technology Monitoring and Evaluation Board (TİDEB) of TUBITAK has R&D assistance program for industrial companies. This includes a financial contribution by the Scientific and Technical Research Council of Turkey and by the Undersecretary of Foreign Trade for up to 60% of the total eligible cost incurred over the duration (up to 36 months) of an individual R&D project.

Low-interest loans are provided by the Technology Development Foundation of Turkey (TTGV) within the scope of the decree.

Two other legal and administrative incentives to promote R&D are: The Decree on Investment Incentives. The decree covers R&D, environment, quality improvement and small medium-sized enterprises (SMEs).

A tax credit for R&D expenses that makes it possible to postpone payment of annual corporate taxes for three years without interest up to an amount equivalent to 20% of R&D expenses. Another fund for R&D studies are provided by the State Planning Organization to relevant university departments for infrastructure developments. Some support is also provided to industry by Electrical Power Resources Survey and Development (EIEI).

Technology Monitoring and Evaluation Board (TİDEB) of TUBITAK, Electrical Power Resources Survey and Development (EIEI) and DPT act as implementing agencies. The applicable ministries have some actions as well. At present, about 15 types of legal and administrative incentives exist to promote R&D, including above mentioned: The Decree on Investment Incentives for small and medium-sized industries (SMES's), A tax credit for R&D expenses. The main renewable energy resources being supported are solar,

geothermal, and wind. Other R&D on the demonstration of advanced bio-fuels technology, such as electricity generation from biomass and liquid bio-fuel production are also underway.

Turkey has joined European Community (EU) Sixth Frame project. There are many projects opportunities in this program about renewable energy. Turkey's universities and research institutes began to offer project proposal.

3.4. Renewable energy pricing and arrangements to subsidize or to oblige the purchase of the electricity from renewable energy

Until recently, The Government State Owned defined the energy prices. The energy-selling price is much higher than OECD countries. As far as tax is concerned, Turkey seems one of the leading nations to put higher taxes on electricity bills, petroleum and other energy types. With recent constitutional and legislative changes, it is expected that energy prices will be defined naturally in the free market, supervised by the independent regulatory bodies.

Until recently, the price and the amount of the energy, which is produced by the renewable power plant was negotiated and accepted by the Ministry of Energy and Natural Resources. With the new Energy Market Law, the price and amount of energy purchased will be defined under the free electricity market conditions.

The numbers of solar and geothermal thermal energy applications in Turkey have been increasing in spite of the lack of specific subsidization. The utilization of biomass except wood is being promoted as well.

4. Analysis of barriers for development of renewable energy and recommendations

The role of the government in formulating and implementing favorable policies for renewable energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in renewable energy development. In order to facilitate rapid replication of renewable technologies, policies should be put in place to encourage the private sector to consider the technologies and to invest in developing and implementing renewable projects. Lack of co-ordination and co-operation within and between various ministries, agencies, institutes and other stakeholders is a major obstacle to further promotion renewable energy technology. It should be continued and expanded co-operation with European member countries in all major energy policy areas. The energy supply and demand should be closely monitored and revised the forecasts to take account of the progress of liberalization, energy efficiency improvements, structural changes in industry and other major factors in order to better inform all players' investment decisions.

The main barriers for development renewable energy are: lack of financial resources and proper lending facilities, particularly for small-scale projects constitute, lack of detailed renewable energy resource assessments and data banks pertains to Turkey like to many other countries. But, lack of awareness and knowledge is not a big barrier in Turkey. Renewable energy is recognized as a major potential for indigenous, clean energy

production. Awareness rising is still a key to involvement, particularly of community based and non-governmental organizations.

The process of liberalization, restructuring and privatization in the energy sector is vital. It should be prevented any delays in the introduction of competition. It should be created a favorable environment for investment.

The most important handicap for foreign investors is Turkish bureaucracy. The permission for a foreign investor can be taken through one-year period with applying numerous different associations. New government had promised to make the permission producer easier.

No subsidy policies exist within this frame. Introduction of both subsidies and ways to overcome commercialization barriers as well as the realization of good practices are of utmost importance. Technology developed and/or transferred needs standardization and then replication. There is a need to evaluate applied renewable energy technologies in detail as a precondition for technology transfer. Environmental protection measures need to be considered in technology development.

High initial capital costs, high operation and management costs must be brought down to attract private investors and facilitate technology transfer. Local production of renewable energy technology can reduce the investment costs significantly.

It was recognized that markets on biomass fuels already exist, including in rural areas, where a large number of people generate income through trade of wood and wood residues, primarily for cooking purposes. But, policy gaps with regards to the supply side of wood fuels from both forest and non-forest sources need to be reduced.

The energy prices should reflect full costs and eliminate subsidies and cross subsidies, both direct and indirect. It should be taken measures to increase transparency in energy regulation and in price setting.

The directive of EC with date of 27 September 2001 and number of 2001/77/EC endorses member countries to cover 12% of the first energy consumption from the renewable sources after the year 2010. The scarcity of renewable energy sources of EC will make the green electric (electric generated from renewable energy sources) import from other countries as Turkey. Turkey may export green electric to European countries by improving the renewable energy sources and by developing the electric interconnection.

In Turkey, natural gas and coal combined cycle power plants with a total capacity of 6000 MW will be in operation till the end of 2003. Besides, it can be seen that there will be an energy generation surplus till the end of 2006. The water level in hydroelectric power plants will be increased. As a result, Turkey will have a new electric distribution system with voltage and frequency control similar to European standards with 2003. At present, Turkey can export total 3400 MW energy; 2400 MW energy through Bulgaria line and 1000 MW through being built Greece line.

In short term, the authority of the determination of valuable geothermal energy generation areas must be given to Energy and Natural Sources Ministry or a committee that can be organized for this duty. At first, they must do the arrangements to generate electricity from these areas. Secondly, the private sector must enter this structure. The experience of The Directorate-General of Mineral Affairs must be used to determine the geothermal energy potential of Turkey.

5. Conclusions

Since, Turkey has limited reserves of oil and natural gas, it is an energy importing country. This situation has caused financial problems. Because of that, the Turkish energy policy is concentrated on assurance of energy supply; reliability, domestic sufficiency, in time, in economic terms, and sustainability. Turkey has inexhaustible renewable energy resources such as solar, hydroelectric, biomass, wind, ocean and geothermal energy. The country has the potential for 125 GW h/year (34,729 MW) of hydropower, 8000 MW of wind power, 35 Mtoe/year of solar energy, 35,000 MW of geothermal energy, 16.92 Mtoe/year of bioenergy. The actual utilization for the year 2001 is 24,010 GW h for hydropower, 152 GW h for wind energy, 287,000 toe for solar energy, 1.759 Mtoe for geothermal energy, 6.98 Mtoe for bioenergy.

Energy development in Turkey has been dominated by public investment and management. But, the government wants to complete the process of liberalization, restructuring and privatization in the energy sector. The country has made early and extensive use of financing models such as build-own-operate (BOO) and build-own-transfer (BOT). As yet, however, no decisive breakthrough has been achieved.

The role of the government in formulating and implementing favorable policies for renewable energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in renewable energy development. The government should investigate which options are viable without financial support. This may be the case for certain hydro projects and for solar thermal applications. The potential of these and other renewable energy sources should be evaluated regularly. For those renewable applications that need support, bidding procedures should be implemented to ensure that the most cost-effective renewable applications are supported.

6. Disclaimer

Although some date taken from govermantal document, this paper are not necessarily representative of the views of goverment.

References

[1] Kaygusuz K, Turker MF. Biomass energy potential in Turkey. Renew Energy 2002;26:661–78.
[2] Boyle G, editor. Renewable energy: power for a sustainable future. Oxford University Press; 1998. p. 1–40.
[3] Ediger ŞV, Kentel E. Renewable energy potential as an alternative to fossil fuels in Turkey. Energy Convers Manage 1999;40:743–55.
[4] Durak M. Yenilenebilir Enerji Kaynaklarına Verilen Teşvikler ve Hedefler. IV Ulusal Temiz Enerji Sempozyumu Bildiri Kitabı 2002 pp. 29–36.
[5] Tosun A. Waste biomass in Turkey and solar drying as a new alternative for its utilization as feed, Submitted to the Institute of Environmental Sciences in Partial fulfillment of the Requirements for the Degree of Doctor of Philosophy. Istanbul: Bogazici University; 1993.
[6] Kaya D, Akgun F, Olgun H, Tiris M, Şener T. Türkiye'nin Biyokütle Potansiyeli ve Enerji Dönüşüm Sistemlerinde Kullanım İmkanları. Termodinamik. December 2002.

[7] Türe S, Uzun D, Türe I†E. The potential use of sweet sorghum as a non-polluting source of energy. Energy Int J 1997;22:17–19.
[8] Kilicaslan I, Sarac HI, Ozdemir E, Ermis K. Sugar cane as an alternative energy source for Turkey. Energy Convers Manage 1999;40:1–11.
[9] Dincer I. Renew energy and sustainable development: a crucial review. Renewable Sust Energy Rev 2000;4: 157–75.
[10] Bayazit M, Avci I. Water resources of Turkey: potential, planning, development and management. Water Resour Develop 1997;13(4):443–52.
[11] Kaygusuz K. Energy situation, future developments, energy saving, and energy efficiency in Turkey. Energy Sources 1999;21:405–16.
[12] Kaygusuz K. Energy and water potential of the Southeastern Anatolia project (GAP). Energy Sources 1999; 21:913–22.
[13] Kaygusuz K. Rural energy resources: applications and consumption in Turkey. Energy Sources 1997;19: 549–58.
[14] Midilli A, Rzayevs P, Olgun H, Ayhan T. Solar hydrogen production from hazelnut shells. Int J Hydrogen Energy 2000;25:723–32.
[15] Kaygusuz K, Ayhan T. Analysis of solar radiation data for Trabzon, Turkey. Energy Convers Manage 1999; 40:545–56.
[16] Kaygusuz K. Sustainable development of hydropower and biomass energy in Turkey. Energy Convers Manage 2002;43:1099–120.
[17] Demirbaş A. Turkey's energy overview beginning in the twenty-first century. Energy Convers Manage 2002;43:1877–87.
[18] Akdeniz F, Çağlar A, Güllü D. Revent energy investigation on fossil and alternative nonfossil resources in Turkey. Energy Conver Manage 2002;43:575–89.
[19] Demirbaş A. Energy balance, energy sources, energy policy, future development and energy investment in Turkey. Energy Convers Manage 2001;42:1239–58.
[20] Ediger ŞV, Tatlıdil H. Forecasting the primary energy demand in Turkey and analysis of cyclic patterns. Energy Convers Manage 2002;43:473–87.
[21] Hanağasıoğlu M. Wind energy In Turkey. Renew Energy 1999;16:822–7.
[22] Meda Project, Diagnostic Study, Questionnaire, 2002.
[23] Kaygusuz K, Sarı A. Renewable energy potential and utilization in Turkey. Energy Convers Manage 2003; 44:459–78.
[24] Energy Policies of IEA Countries. Turkey 2001 Review. Paris, France: International Energy Agency.
[25] http://www.enerji.gov.tr.